CLAIMS

1. An optically controlled optical-path-switching-type optical signal transmission apparatus comprising:

a signal light beam light source for irradiating a signal light beam having one (1) or more wavelengths;

a control light beam light source for irradiating a control light beam having two (2) or more wavelengths that are different from those of the signal light beam;

two (2) or more light-absorbing layer films for transmitting the signal light beam and selectively absorbing respectively only one (1) specific wavelength of the control light beam;

means for respectively converging and irradiating the control light beam and the signal light beam to each of the light-absorbing layer films;

two (2) or more thermal lens forming devices for causing the converged signal light beam to exit while maintaining beam convergence, or for varying the angle of divergence of the signal light beam and for causing the signal beam to exit, in response to the presence or absence of irradiation of the one (1) specific wavelength of the control light beam, by using a thermal lens containing the light-absorbing layer films and based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof; and

a plurality of mirrors, one provided after each of the thermal lens forming devices and having a hole and reflecting means, for passing the signal light beam having exited the thermal lens forming devices through the hole or deflecting the optical path of the signal light beam by reflecting the signal light beam by the reflecting means in response to the presence or absence of irradiation of the one (1) specific wavelength of the control light beam.

2. An optically controlled optical-path-switching-type optical signal transmission apparatus comprising:

a signal light beam light source for irradiating a signal light beam having one (1) or more wavelengths;

a control light beam light source for irradiating a control light beam having two (2) or more wavelengths that are different from those of the signal light beam;

two (2) or more light-absorbing layer films for transmitting the signal light beam and selectively absorbing respectively only one (1) specific wavelength of the control light beam;

means for respectively converging and irradiating the control light beam and the signal light beam to each of the light-absorbing layer films; and

two (2) or more sets of optical path switching mechanism each comprising a combination of a thermal lens forming device and a mirror having a hole, wherein

the thermal lens forming device includes the light-absorbing layer films and, by using a thermal lens

based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof, causes the converged signal light beam to exit with an ordinary divergence angle when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed, and causes the converged signal light beam to exit with a divergence angle larger than the ordinary divergence angle when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed, the thermal lens forming device thus changing the divergence angle of the signal light beam directed to exit in response to the presence or absence of irradiation of the one (1) specific wavelength of the control light beam, and wherein

the hole in the mirror having is provided for passing either the signal light beam output from the thermal lens forming device with the ordinary divergence angle as is, or the signal light beam with the divergence angle varied by a light-receiving lens when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed, and reflecting means for reflecting either the signal light beam output diverging from the thermal lens forming device with the divergence angle larger than the ordinary divergence angle as is, or the signal light beam with the divergence angle varied by the light-receiving lens when the one (1) specific wavelength

of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an incidence surface of the light-absorbing layer film, the mirror changing the optical paths.

3. An optically controlled optical-path-switching-type optical signal transmission apparatus comprising:

a signal light beam light source for irradiating a signal light beam having one (1) or more wavelength(s);

a control light beam light source for irradiating a control light beam having two (2) or more wavelengths that are different from those of the signal light beam;

two (2) or more light-absorbing layer films for transmitting the signal light beam and selectively absorbing respectively only one (1) specific wavelength of the control light beam;

means for respectively converging and irradiating the control light beam and the signal light beam to each of the light-absorbing layer films; and

two (2) or more sets of optical path switching mechanism each comprising a combination of a thermal lens forming device and a mirror having a hole, wherein

the thermal lens forming device includes the light-absorbing layer films and, by using a thermal lens based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam

and in the periphery thereof, causes the converged signal light beam to exit as converged when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed, and causes the converged signal light beam to exit with an ordinary divergence angle when the control light beam has not been irradiated and no thermal lens has been formed, the thermal lens forming device thus changing the divergence angle of the signal light beam directed to exit in response to the presence or absence of irradiation of the one (1) specific wavelength of the control light beam, and wherein

the hole in the mirror having a hole is provided for passing the converged signal light beam output from the thermal lens forming device as converged when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an exiting surface of the light-absorbing layer film, and reflecting means for reflecting either the signal light beam output from the thermal lens forming device with the ordinary divergence angle as is, or the signal light beam that has passed through a light-receiving lens provided for changing the divergence angle when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed, the mirror changing the optical paths.

4. An optically controlled optical-path-switching-type optical signal transmission apparatus comprising:

a signal light beam light source for irradiating a signal light beam having one (1) or more wavelength(s);

a control light beam light source for irradiating a control light beam having two (2) or more wavelengths that are different from those of the signal light beam;

two (2) or more light-absorbing layer films for transmitting the signal light beam and selectively absorbing respectively only one (1) specific wavelength of the control light beam;

means for respectively converging and irradiating the control light beam and the signal light beam to each of the light-absorbing layer films;

one (1) or more sets of first optical path switching mechanism each comprising a combination of a first thermal lens forming device and a first mirror having a hole; and

one (1) or more sets of second optical path switching mechanism each comprising a combination of a second thermal lens forming device and a second mirror having a hole, wherein

the first thermal lens forming device includes the light-absorbing layer films and, by using a thermal lens based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof, causes the converged signal light beam to exit with an ordinary divergence angle when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed,

and causes the converged signal light beam to exit with a divergence angle larger than the ordinary divergence angle when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an incidence surface of the light-absorbing layer film, the first thermal lens forming device thus changing the divergence angle of the signal light beam directed to exit in response to the presence or absence of irradiation of the one (1) specific wavelength of the control light beam, wherein

the hole in the first mirror having a hole is provided for passing either the signal light beam output from the thermal lens forming device with the ordinary divergence angle as is, or the signal light beam with the divergence angle varied by a light-receiving lens when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed, and reflecting means for reflecting either the signal light beam output diverging from the thermal lens forming device with the divergence angle larger than the ordinary divergence angle as is, or the signal light beam with the divergence angle varied by the light-receiving lens when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an incidence surface of the light-absorbing layer film, wherein

the second thermal lens forming device contains the light-absorbing layer films and, by using a thermal lens based on a distribution of refractive index produced

reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof, causes the converged signal light beam to exit as converged when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an exiting surface of the light-absorbing layer film, and causes the converged signal light beam to exit with an ordinary divergence angle when the control light beam has not been irradiated and no thermal lens has been formed, the second thermal lens forming device thus changing the divergence angle of the signal light beam directed to exit in response to the presence or absence of irradiation of the one (1) specific wavelength of the control light beam, and wherein

the hole in the second mirror having a hole is provided for passing the converged signal light beam output from the thermal lens forming device as converged when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an exiting surface of the light-absorbing layer film, and reflecting means for reflecting either the signal light beam output from the thermal lens forming device with the ordinary divergence angle as is, or the signal light beam that has passed through the light-receiving lens provided for changing the divergence angle when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed, the second mirror

changing the optical paths.

5. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 2, wherein the two (2) or more sets of optical path switching mechanism are connected in series directly through a space or through an optical-fiber-connection system.

6. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 3, wherein the two (2) or more sets of optical path switching mechanism are connected in series directly through a space or through an optical-fiber-connection system.

7. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 4, wherein the two (2) or more sets of optical path switching mechanism are connected in series directly through a space or through an optical-fiber-connection system.

8. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 2, wherein the three (3) or more sets of optical path switching mechanism are connected in a multi-stage configuration directly through a space or through an optical-fiber-connection system, branching in each one (1) stage of the connection in two (2) directions of a direction for a light beam to travel straight through the hole of the

mirror and a direction for a light beam to be reflected.

9. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 3, wherein the three (3) or more sets of optical path switching mechanism are connected in a multi-stage configuration directly through a space or through an optical-fiber-connection system, branching in each one (1) stage of the connection in two (2) directions of a direction for a light beam to travel straight through the hole of the mirror and a direction for a light beam to be reflected.

10. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 4, wherein the three (3) or more sets of optical path switching mechanism are connected in a multi-stage configuration directly through a space or through an optical-fiber-connection system, branching in each one (1) stage of the connection in two (2) directions of a direction for a light beam to travel straight through the hole of the mirror and a direction for a light beam to be reflected.

11. A method of switching optical paths for optical signals comprising the steps of:

causing a signal light beam having one (1) or more wavelengths and a control light beam having two (2) or more wavelengths that are different from those of the signal light beam to travel substantially coaxial and in the same

direction;

converging and irradiating respectively the control light beam and the signal light beam to each of two (2) or more light-absorbing layer films that transmits the signal light beam and absorbs selectively only one specific wavelength of the control light beam;

at each of two (2) or more thermal lens forming devices each containing the light-absorbing layer films, by using a thermal lens based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof, in response to the presence or absence of irradiation of the control light beam having the one (1) specific wavelength, causing the converged signal light beam to exit as converged or to exit varying the divergence angle thereof; and

using a hole-provided mirror having a reflecting surface, in response to the presence or absence of irradiation of the control light beam of the one (1) specific wavelength, causing the signal light beam output from the thermal lens forming device to travel straight from the hole or changing the optical paths thereof by reflecting the signal light beam at the reflecting surface.

12. A method of switching optical paths for optical signals comprising the steps of:

causing a signal light beam having one (1) or more

wavelength(s) and a control light beam having two (2) or more wavelengths that are different from those of the signal light beam to travel substantially coaxial and in the same direction;

converging and irradiating respectively the control light beam and the signal light beam to each of two (2) or more light-absorbing layer films that transmits the signal light beam and absorbs selectively only one specific wavelength of the control light beam;

at each of two (2) or more thermal lens forming devices each containing the light-absorbing layer films, by using a thermal lens based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof, causing the converged signal light beam to exit from the thermal lens forming device with an ordinary divergence angle when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed in the vicinity of an incidence surface of the light-absorbing layer film, and causing the converged signal light beam to exit from the thermal lens forming device with a divergence angle larger than the ordinary divergence angle when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed, and causing the divergence angle of the signal light beam directed to exit to vary in response to presence/absence of irradiation of the control

light beam having the one (1) specific wavelength;

passing through the hole of a hole-provided mirror either the signal light beam output from the thermal lens forming device with the ordinary divergence angle as is, or the signal light beam with the divergence angle varied by a light-receiving lens when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed; and

reflecting, using a reflecting surface of the hole-provided mirror, either the signal light beam output diverging from the thermal lens forming device with the divergence angle larger than the ordinary divergence angle as is, or the signal light beam with the divergence angle varied by a light-receiving lens when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an incidence surface of the light-absorbing layer film and, thereby, changing the optical paths.

13. A method of switching optical paths comprising the steps of:

causing a signal light beam having one (1) or more wavelength(s) and a control light beam having two (2) or more wavelengths that are different from those of the signal light beam to travel substantially coaxial and in the same direction;

converging and irradiating the control light beam and the signal light beam to each of two (2) or more

light-absorbing layer films that transmits the signal light beam and absorbs selectively only one specific wavelength of the control light beam;

at each of two (2) or more thermal lens forming devices each containing the light-absorbing layer films, by using a thermal lens based on a distribution of refractive index produced reversibly caused by temperature increase generated in an area of the light-absorbing layer film that has absorbed the one (1) specific wavelength of the control light beam and in the periphery thereof, causing the converged signal light beam to exit as converged when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an exiting surface of the light-absorbing layer film, and causing the converged signal light beam to exit with an ordinary divergence angle when the control light beam has not been irradiated and no thermal lens has been formed, and changing the divergence angle of the signal light beam directed to exit in response to the presence or absence of irradiation of the control light beam having the one (1) specific wavelength;

causing the converged signal light beam output from the thermal lens forming device as converged to pass through the hole of the hole-provided mirror and to travel straight when the one (1) specific wavelength of the control light beam has been irradiated and a thermal lens has been formed in the vicinity of an exiting surface of the light-absorbing layer film; and

changing the optical path by reflecting using a reflecting surface of the hole-provided mirror either the optical path of the signal light beam output from the thermal lens forming device with the ordinary divergence angle as is, or the signal light beam of which the divergence angle has been changed the light-receiving lens when the one (1) specific wavelength of the control light beam has not been irradiated and no thermal lens has been formed.

14. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 2, wherein, among light beams having a plurality of wavelengths, a light beam having the longest wavelength is set as the signal light beam and two (2) or more light beams having a wavelength shorter than that of the signal light beam are set as the control light beam, the optical path switching mechanism for which the wavelength that the thermal lens forming device therein absorbs is the shortest is set as a first stage, and the optical path switching mechanisms in the latter stages are connected in increasing order of the wavelength absorbed by each of the thermal lens forming devices.

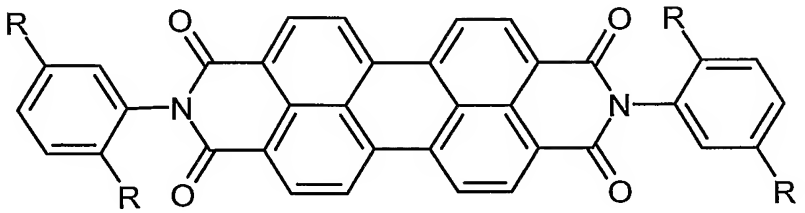
15. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 3, wherein, among light beams having a plurality of wavelengths, a light beam having the longest wavelength is set as the signal light beam and two (2) or more light beams

having a wavelength shorter than that of the signal light beam are set as the control light beam, the optical path switching mechanism for which the wavelength that the thermal lens forming device therein absorbs is the shortest is set as a first stage, and the optical path switching mechanisms in the latter stages are connected in increasing order of the wavelength absorbed by each of the thermal lens forming devices.

16. An optically controlled optical-path-switching-type optical signal transmission apparatus according to claim 4, wherein, among light beams having a plurality of wavelengths, a light beam having the longest wavelength is set as the signal light beam and two (2) or more light beams having a wavelength shorter than that of the signal light beam are set as the control light beam, the optical path switching mechanism for which the wavelength that the thermal lens forming device therein absorbs is the shortest is set as a first stage, and the optical path switching mechanisms in the latter stages are connected in increasing order of the wavelength absorbed by each of the thermal lens forming devices.

17. An optically controlled optical-path-switching-type optical signal transmission apparatus according to any one of claims 1 to 10 and claims 14 to 16, wherein the light-absorbing layer film contains two (2) or more pigments selected from a group consisting of:

N, N'-bis(2, 5-di-*tert*-butylphenyl)-3, 4, 9, 10-perylenedicarboxyimide) [1],

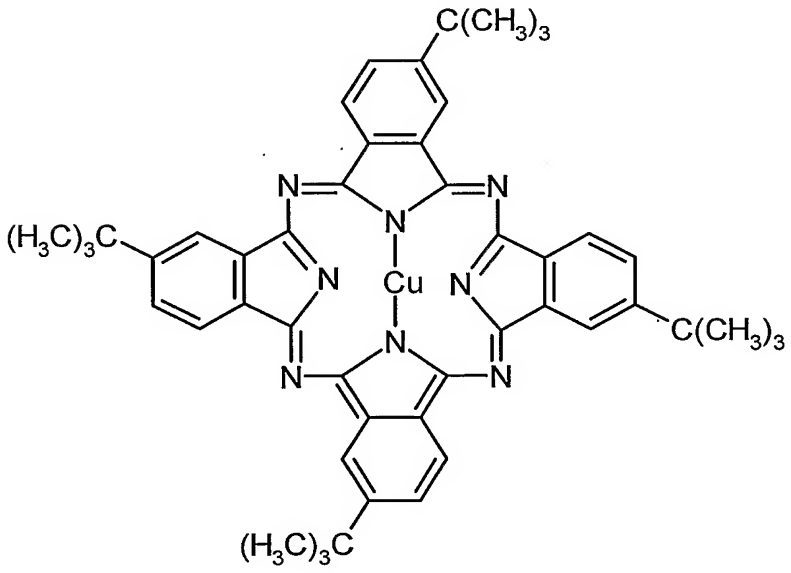


[R = $C(CH_3)_3$]

...[1]

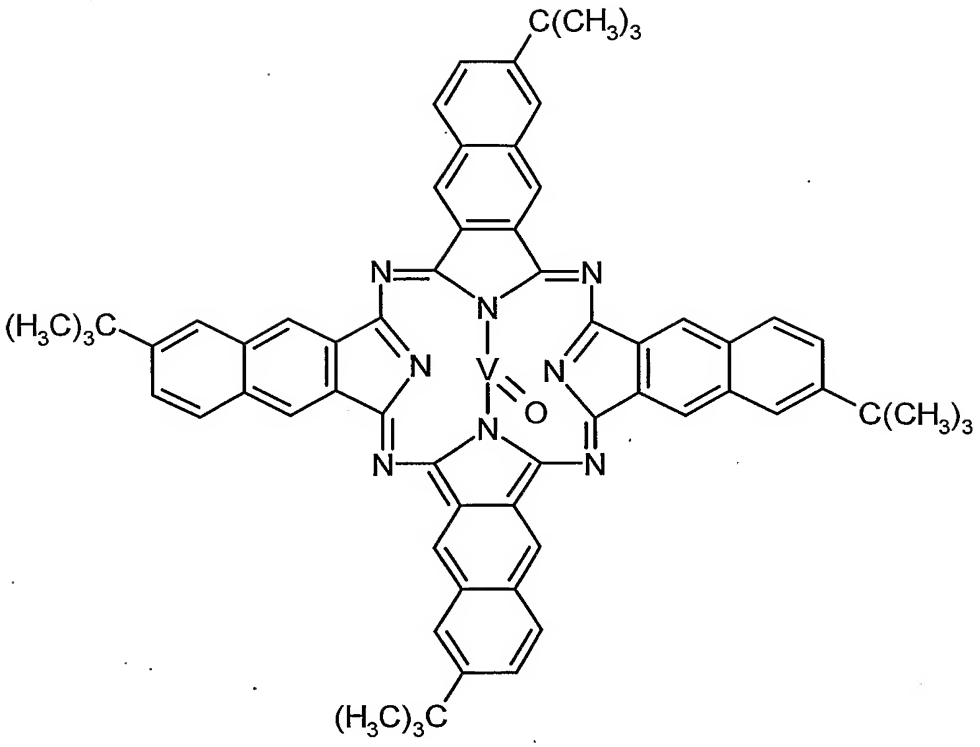
10

Copper(11)2, 9, 16, 23-tetra-*tert*-butyl-29H, 31H-phthalocyanine [2],



...[2]; and

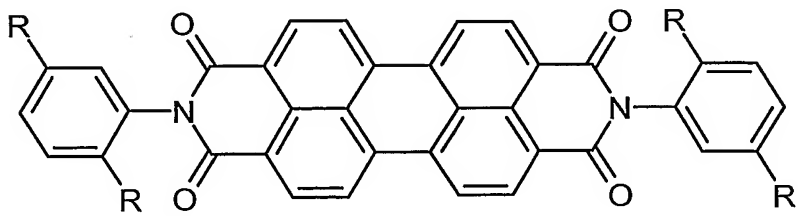
Vanadyl 2, 11, 20, 29-tetra-*tert*-butyl-2, 3-naphthalocyanine [3],



...[3]

18. An optically controlled optical-path-switching-type optical signal transmission apparatus according to any one of claims 11 to 13, wherein the light-absorbing layer film contains two (2) or more pigments selected from a group consisting of:

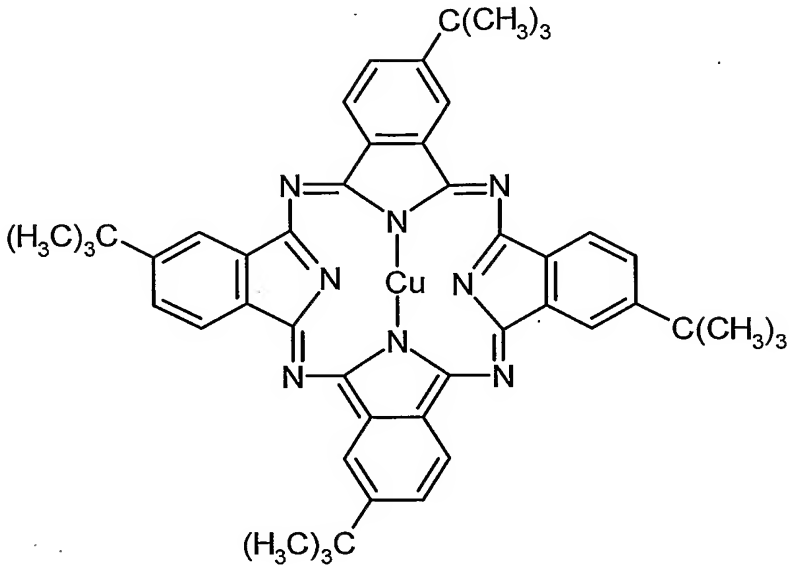
N, N'-bis(2, 5-di-*tert*-butylphenyl)-3, 4, 9, 10-perylenedicarboxyimide) [1],



...[1]

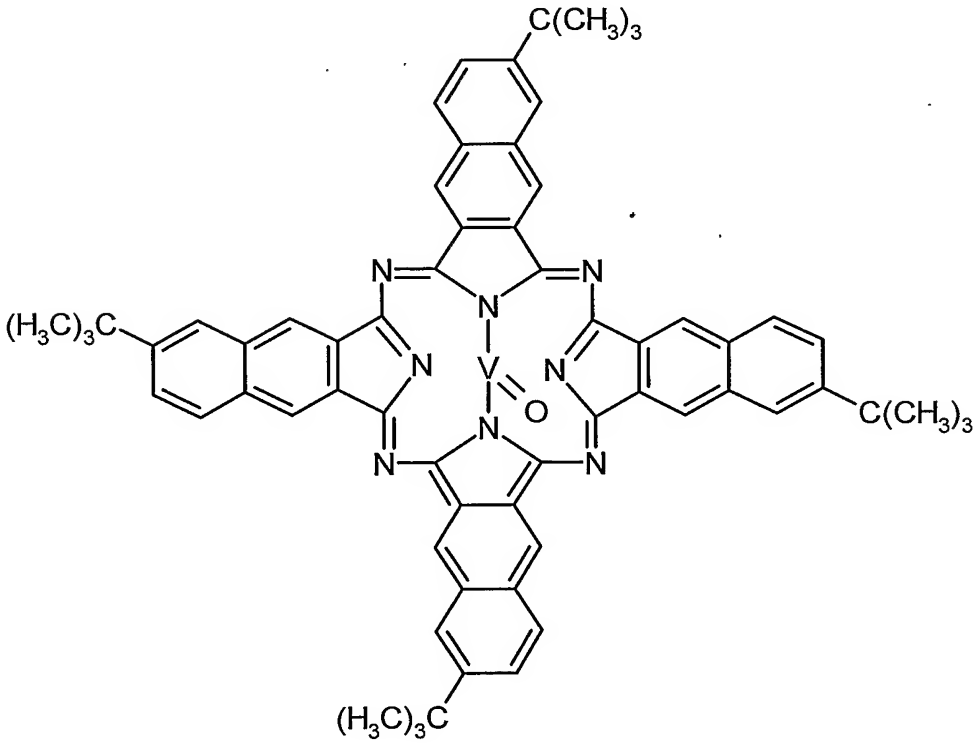
[R = $C(CH_3)_3$]

Copper(11)2, 9, 16, 23-tetra-*tert*-butyl-29H, 31H-phthalocyanine [2],



...[2]; and

Vanadyl 2, 11, 20, 29-tetra-*tert*-butyl-2, 3-naphthalocyanine [3],



...[3].